AeroVironment

Delco Propulsion Systems

GM HYBRID VEHICLES

MRI

An Electric Drive System for Series Hybrid Vehicles

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Abstract

Delco Propulsion Systems and AeroVironment have been working on several projects related to the Department of Energy Hybrid Electric Vehicle programs. The main emphasis of this paper is on the Power Electronics Bay (PEB) and the Electric Drive Unit (EDU).

The PEB consists of the propulsion inverter of 60 kW continuous and peak power of 110 kW, HVAC inverter and controller of 4 kW, DC-DC converter of 2 kW for converting the main battery voltage to 12 V nominal, electric power steering inverter of 2.5 kW, and heater controller. All the power units are mounted on the same heat sink. The power switching devices of the inverter are automotive grade latest generation IGBT modules from Delco Electronics. The digital signal processor based field orientated motor controller is a part of the system controller also mounted in the PEB. The propulsion inverter has the following protections: over voltage, over current, under voltage, over temperature, over speed, and short circuit protection. The HVAC motor controller is a 4 kW peak IGBT based inverter designed to run a permanent magnet motor. The motor is operated without using any position sensors. This is accomplished by measuring the phase voltage across the terminal of the motor and suitably timing the commutations based on this information.

The EDU is a 160 HP high efficiency, high power density induction motor with fully integrated fixed gear reduction designed to produce a torque-speed curve to match that of a 3800 cc General Motors internal combustion engine. It is capable of providing 245 ft. lb. of stall torque with efficiencies reaching 93% and speeds up to 12,000 RPM. The fixed reduction is a three stage offset helical gear set with a ratio of 10.2:1 and utilizes a splash lubrication system thereby eliminating the need for an oil pump. The stator is cooled by a water glycol loop integrated into the housing.

Both the PEB and the EDU have been extensively tested on a dynamometer and have achieved system efficiencies up to 91.5%. They have also been tested in a vehicle and they perform smoothly with low noise.